Profiler Applications

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I. Boundary layer height
II. Temperature (RASS)

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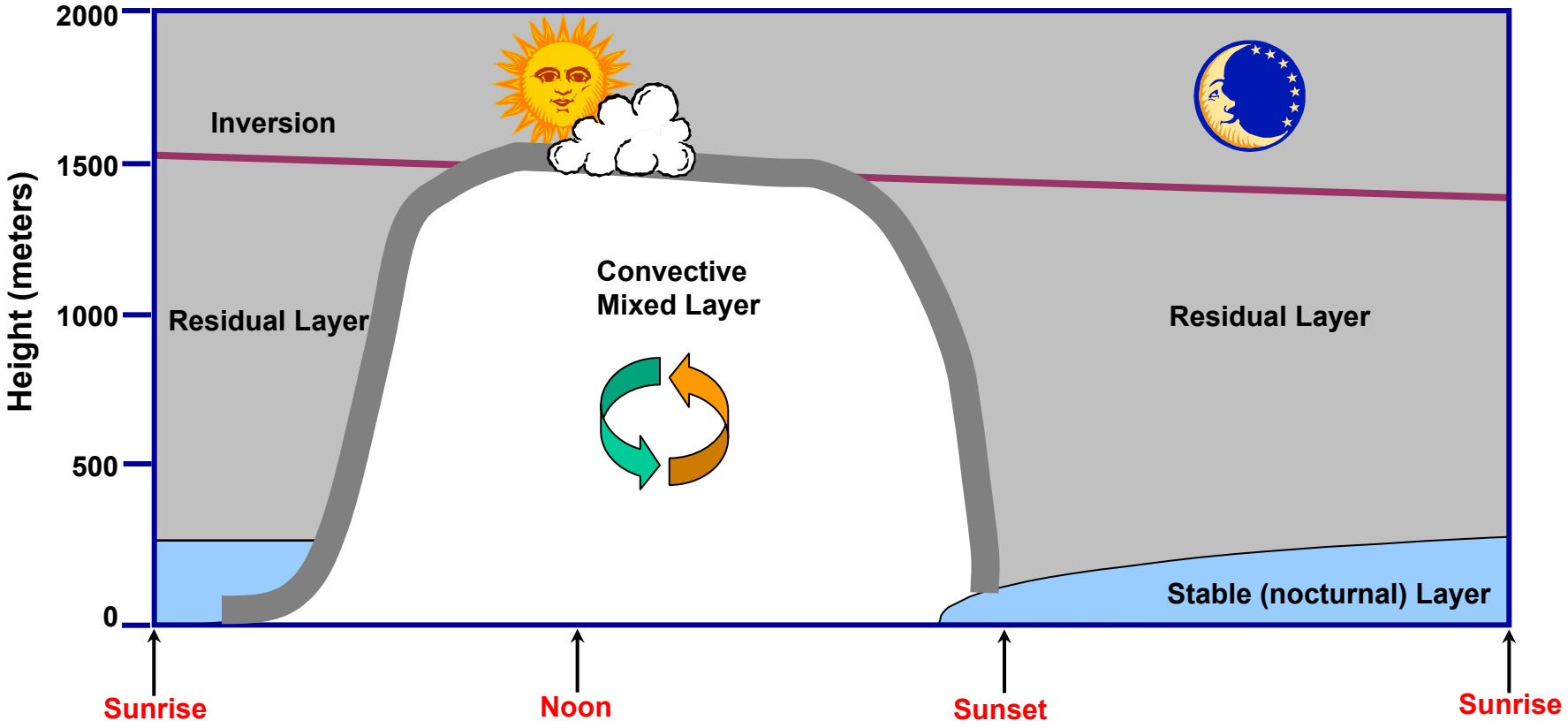
III. Turbulence intensity
IV. Weather phenomena

Profiler Applications

I. Boundary layer height
   - Orientation
   - Reflectivity patterns
   - Complications
   - More information to aid interpretation

II. Temperature (RASS)
   - Accuracy, precision, and biases
   - Applications

Atmospheric Boundary Layer
Diurnal Variation



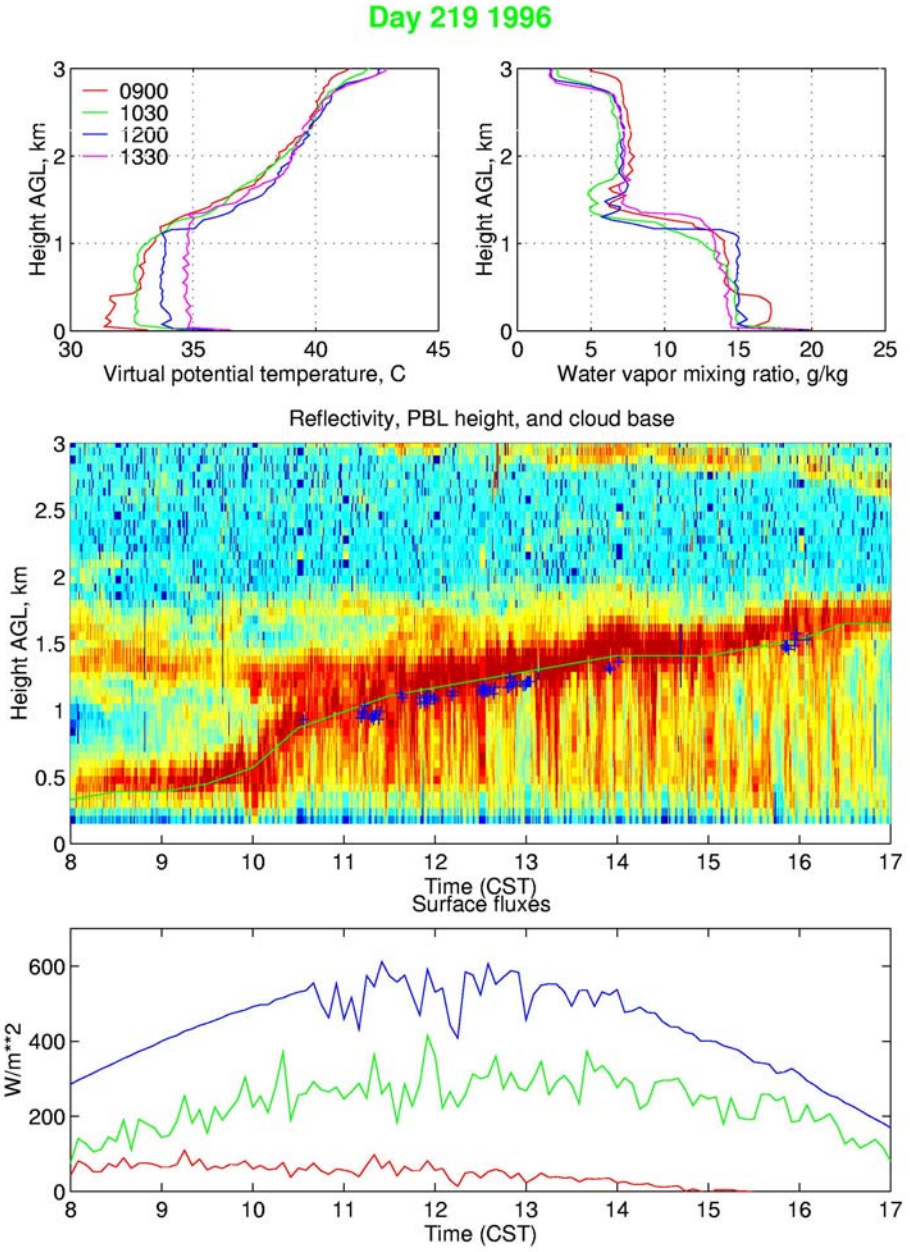
Adapted from **Introduction to Boundary Layer Meteorology** -R.B. Stull, 1988

How is BL height found?

- Primary method uses reflectivity pattern
  - Reflectivity peaks at BL top, providing a sharp indication
- Other parameters are used to clarify difficult or ambiguous cases
  - Ceilometer cloud base
  - Spectral width
  - RASS temperature

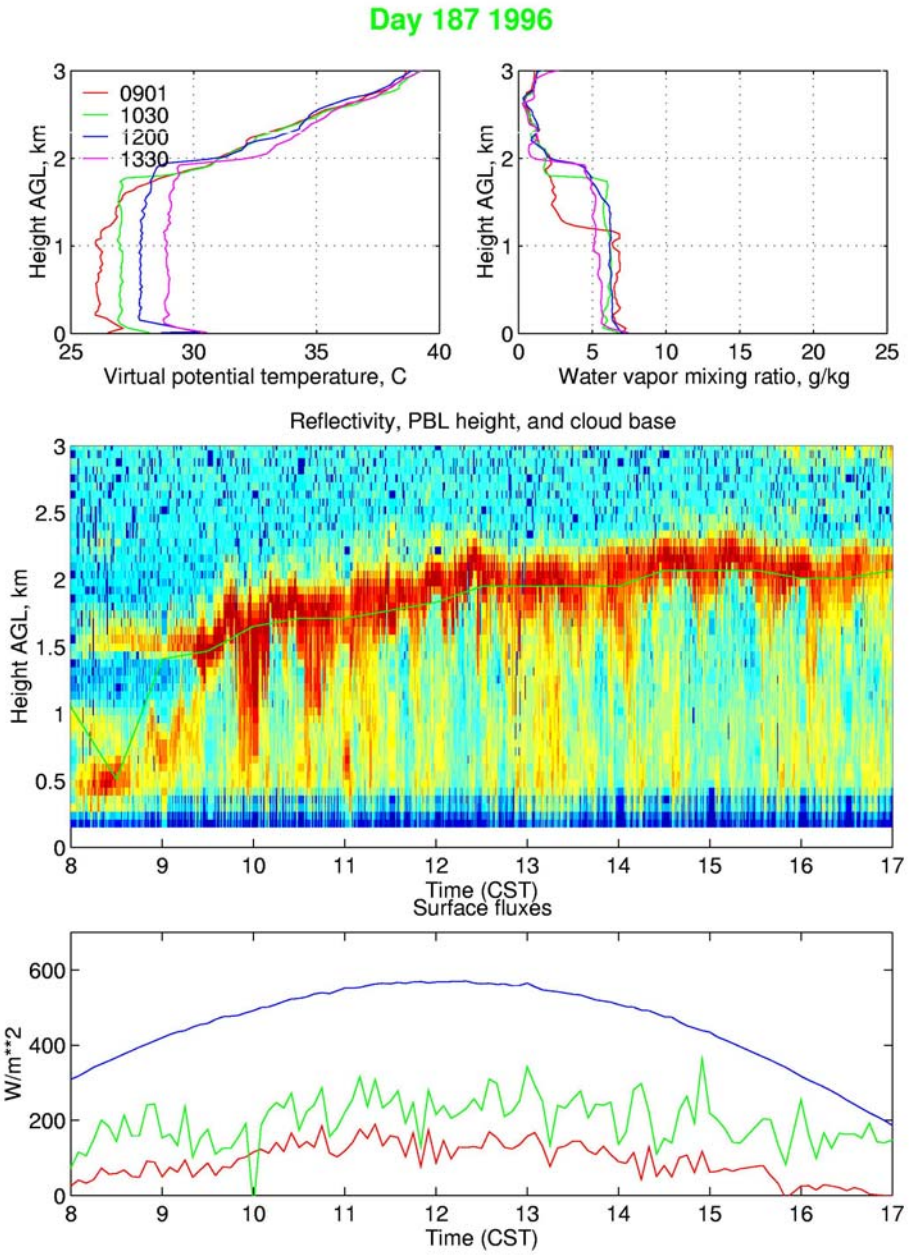
How does a profiler see the ABL?

- Reflectivity is roughly the product of humidity gradient and turbulence intensity



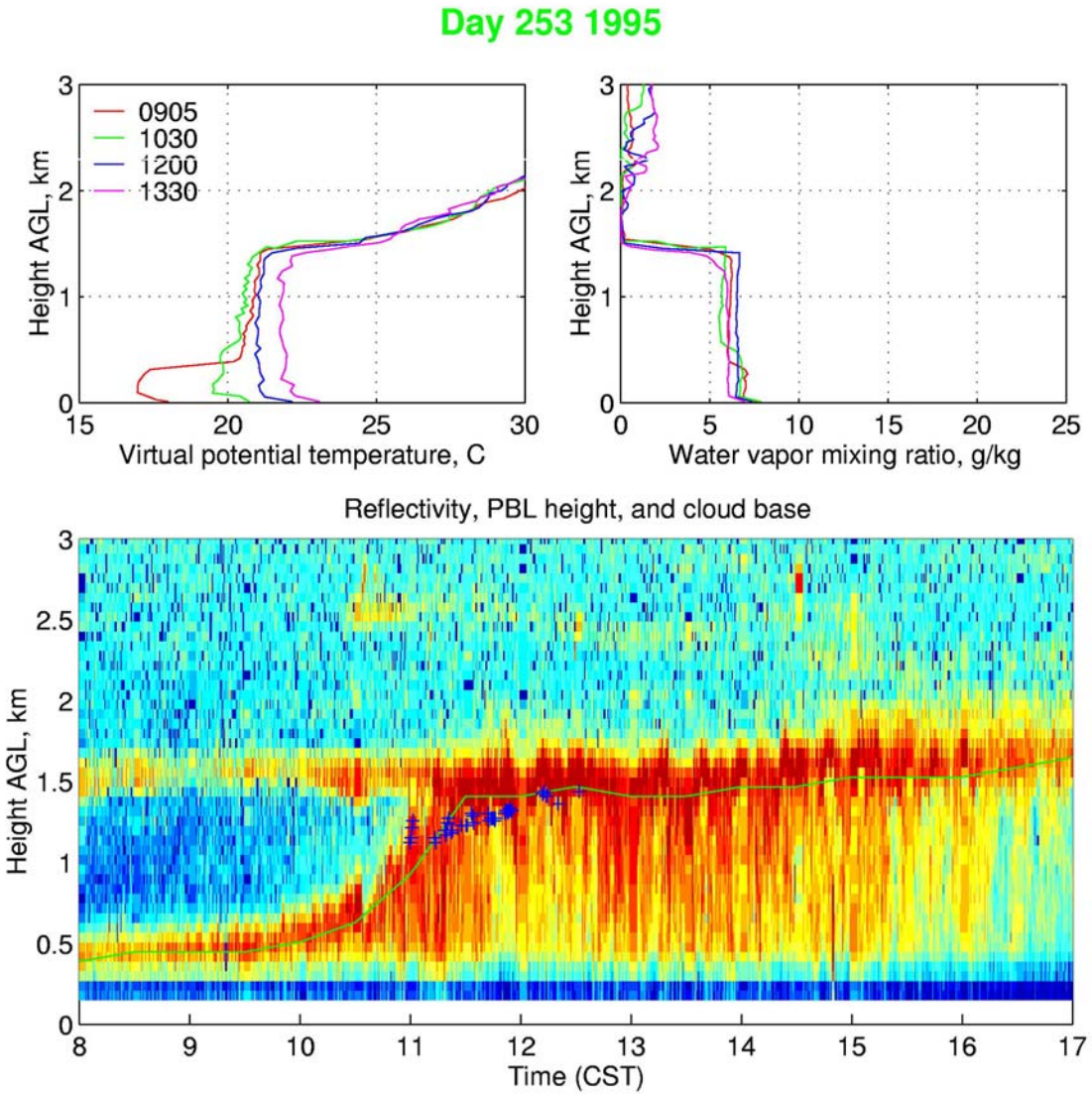
Deep layer

- Note deep entrainment signatures



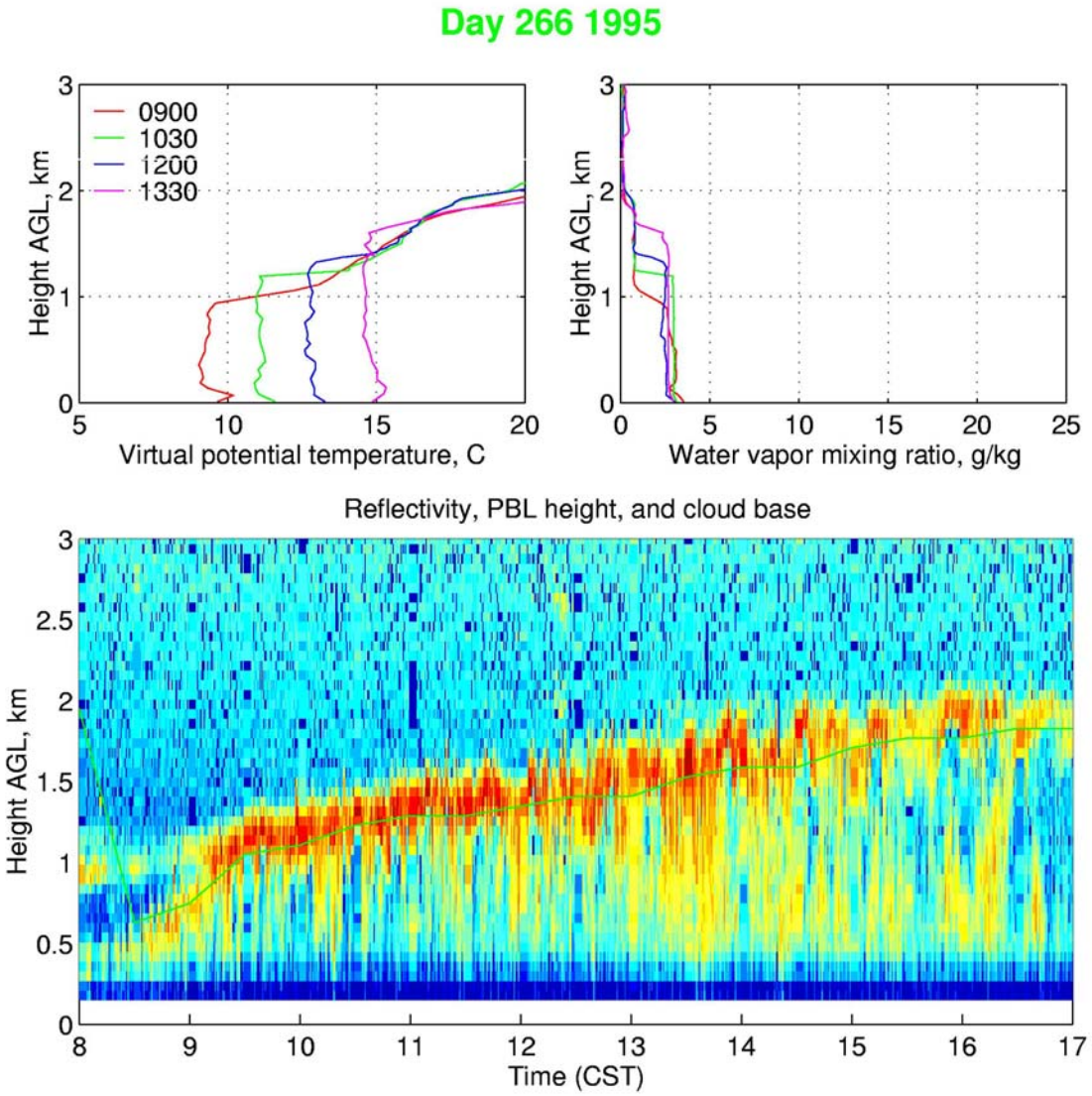
Residual layer

- Can fool simple automated algorithms



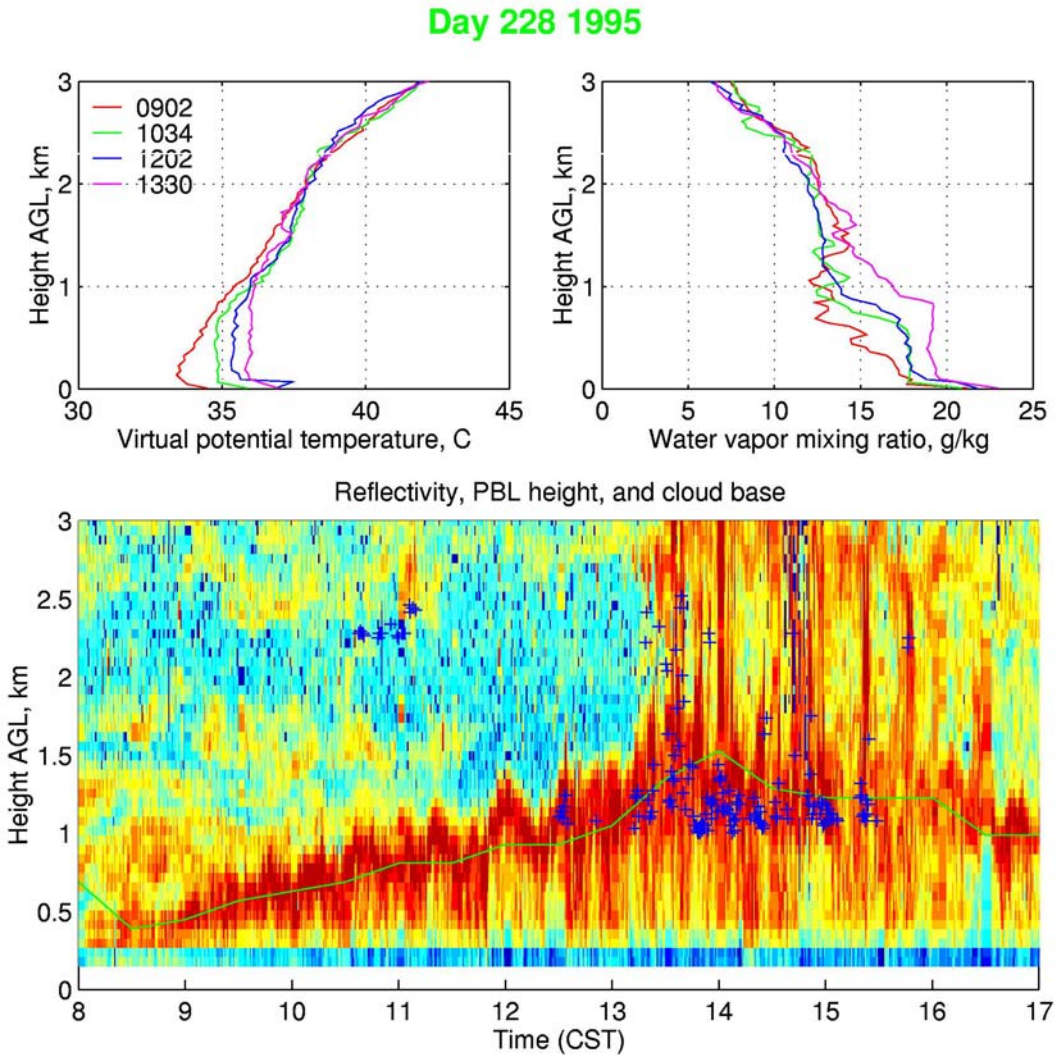
Low humidity

- Weakens signal



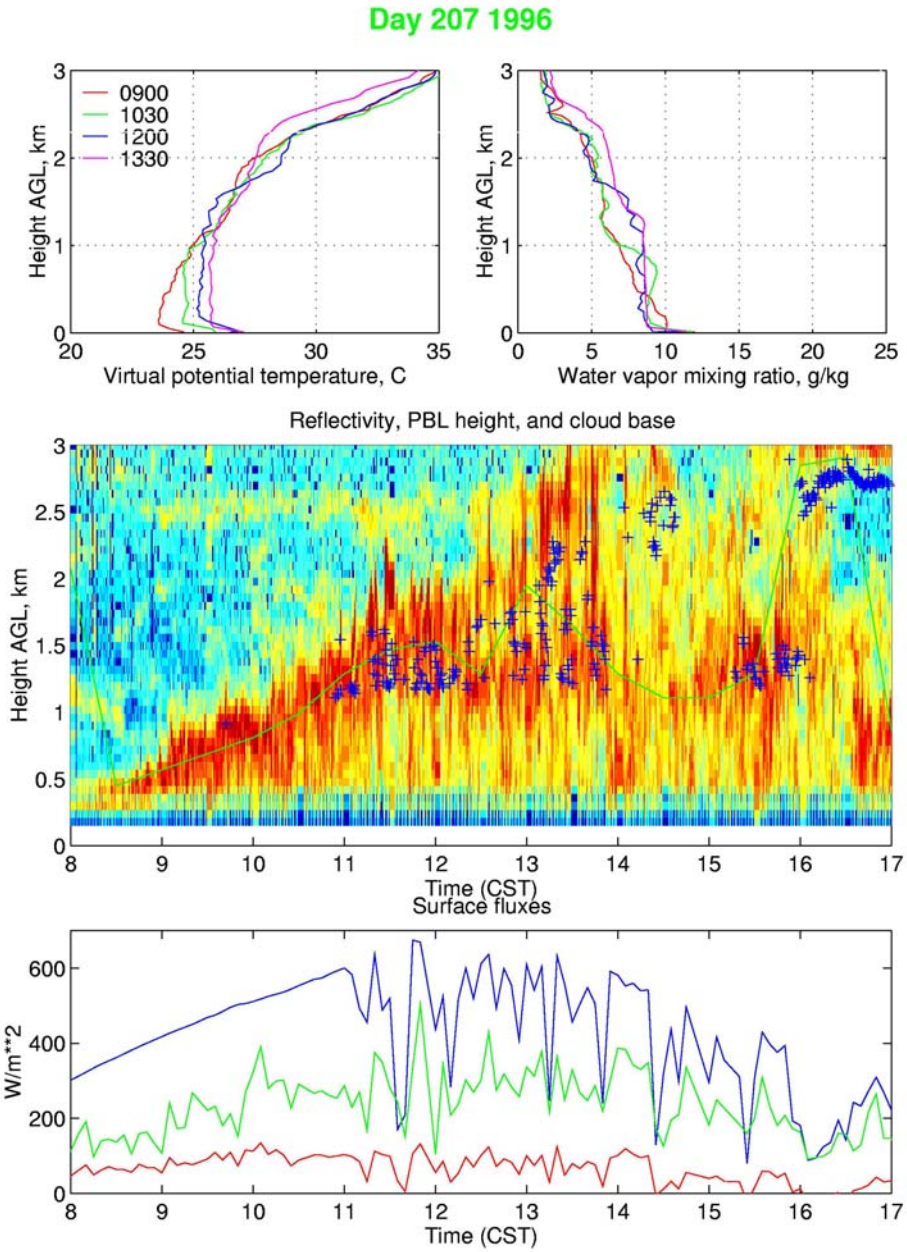
Weak inversion, cloud

- Broad or weak inversion
- “Deep” but non-precipitating cloud
- Ceilometer aids greatly in interpretation



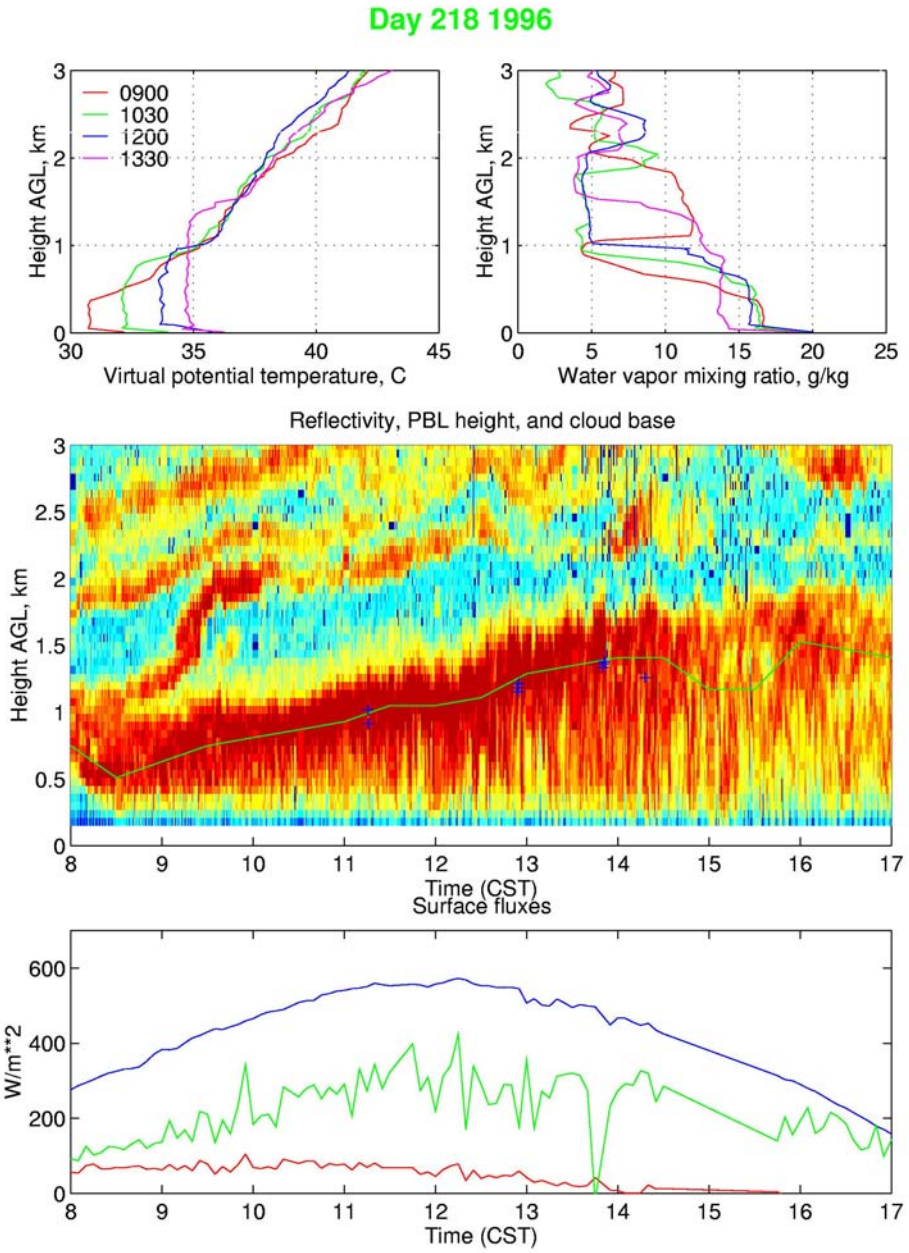
Weak inversion, cloud

- Note disappearance of BL signature 1400-1500 CST



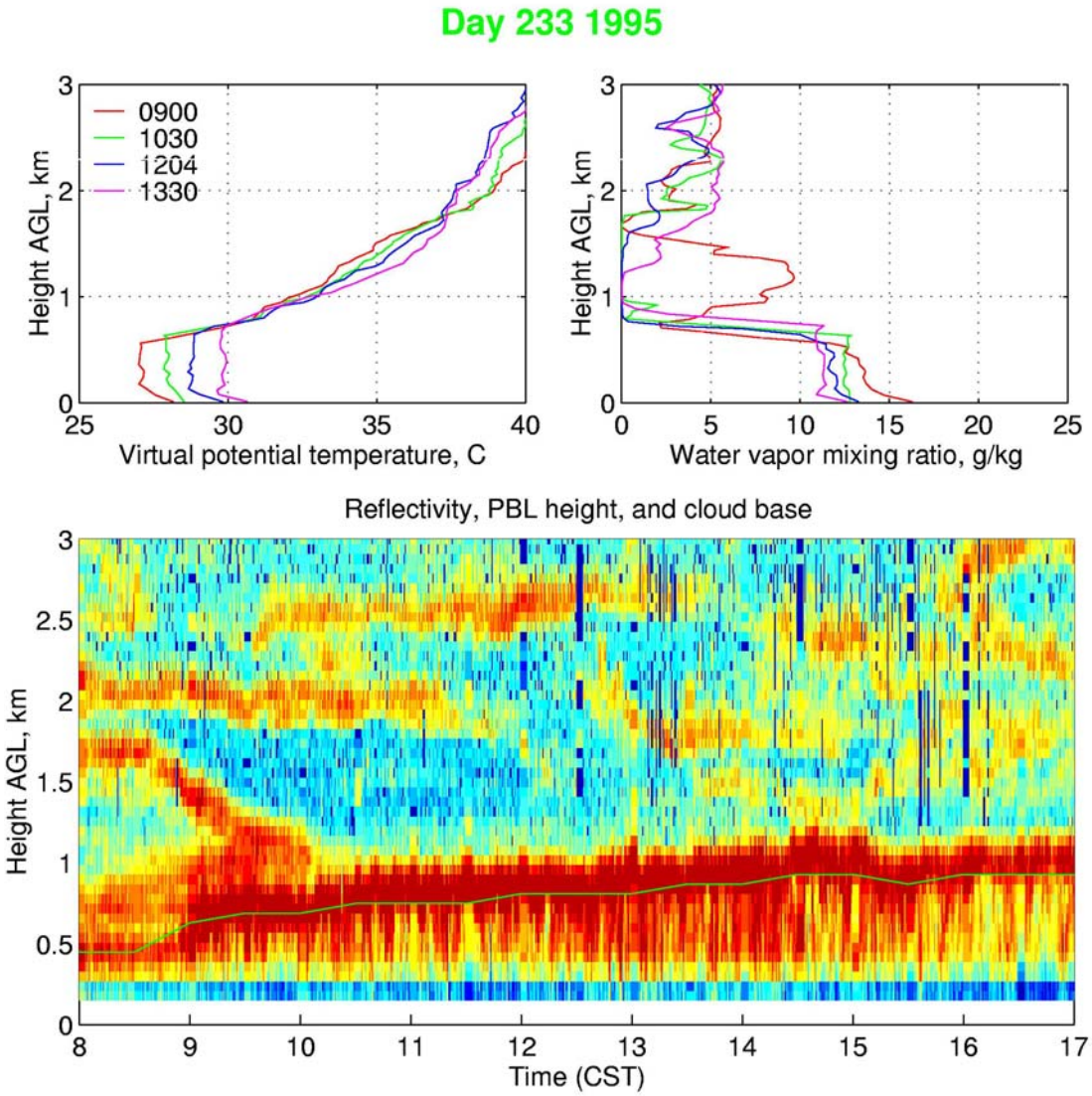
Multiple layers

- Note correlation of layers to soundings



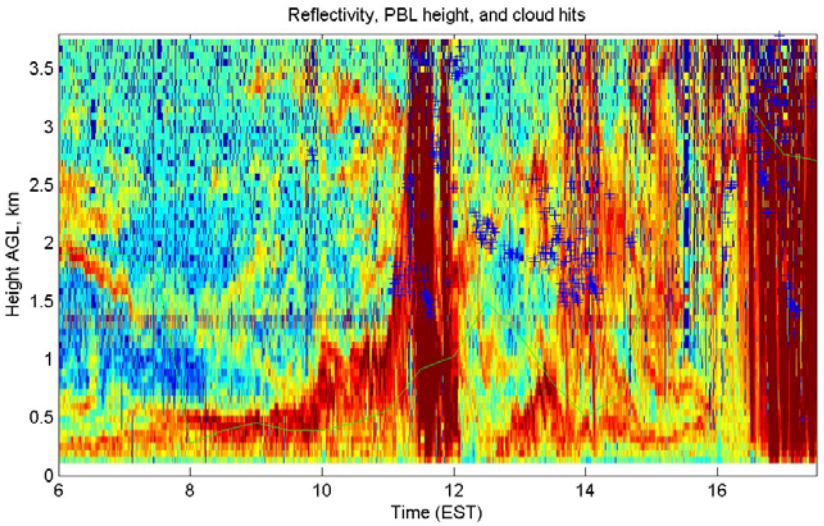
Multiple layers

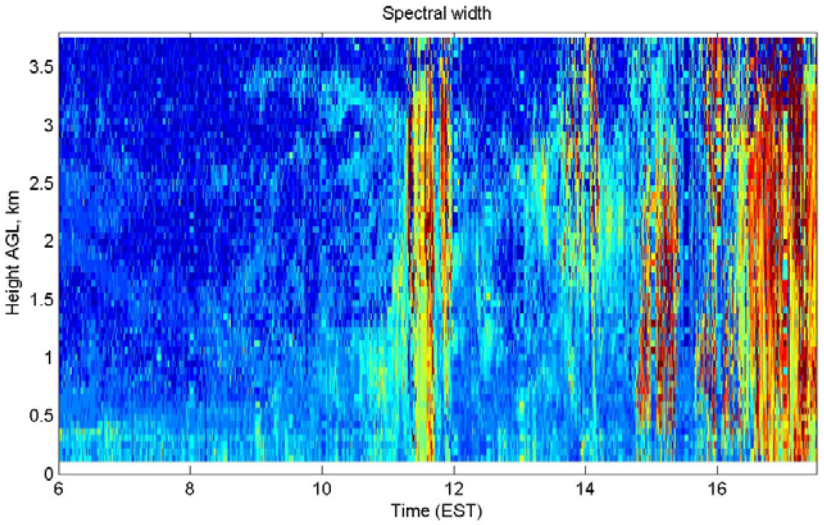
- Can fool simple automated algorithms



Overcast and rain

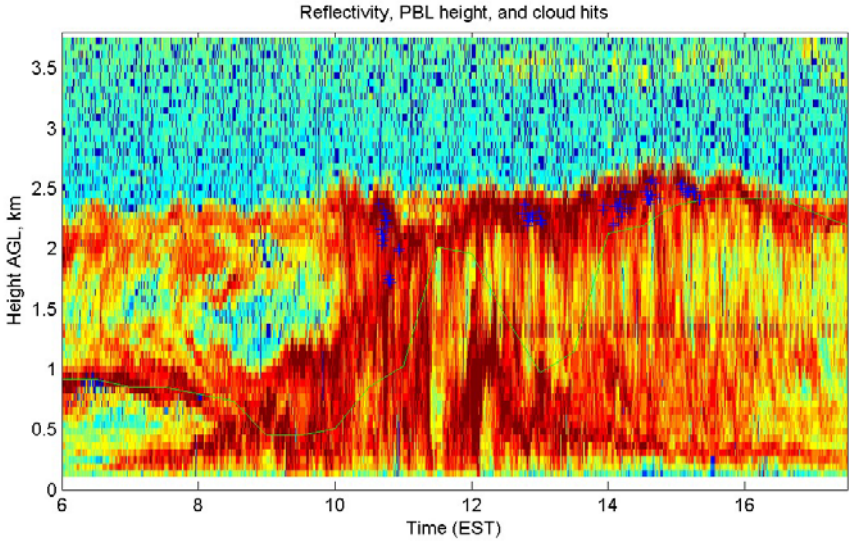
- (Pease day 196 2002)

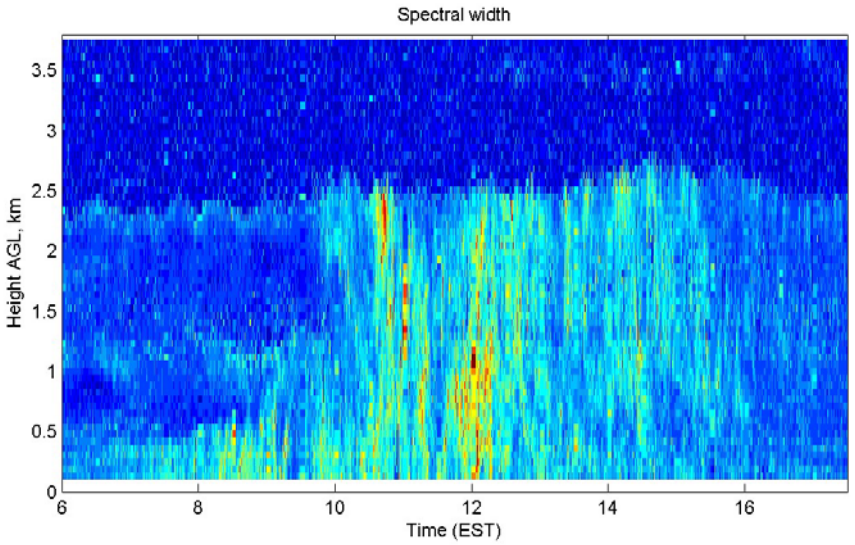




Coastal BL with sea breeze

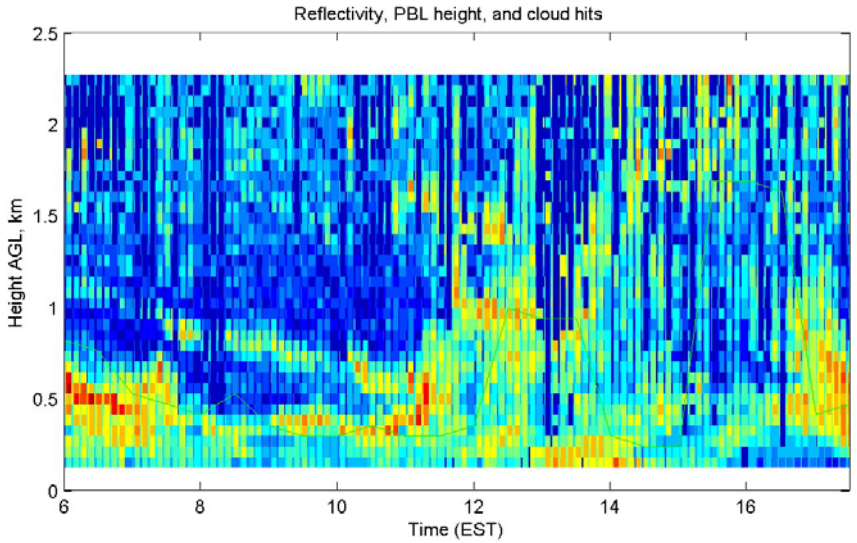
- (Pease day 215 2002)

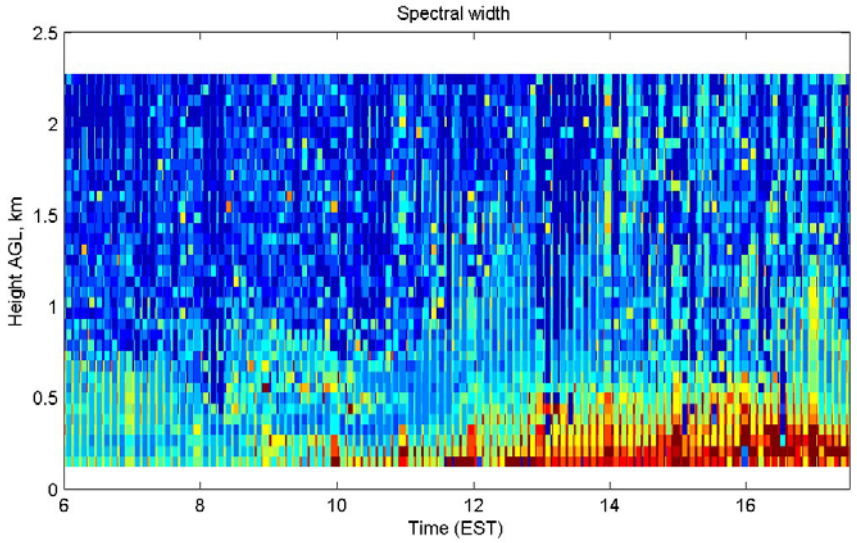




Marine BL

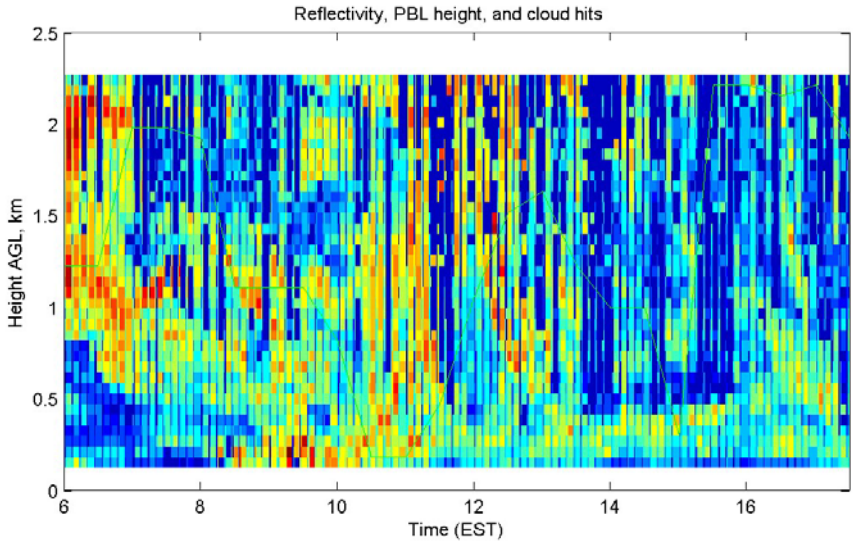
- (Appledore day 181 2002)

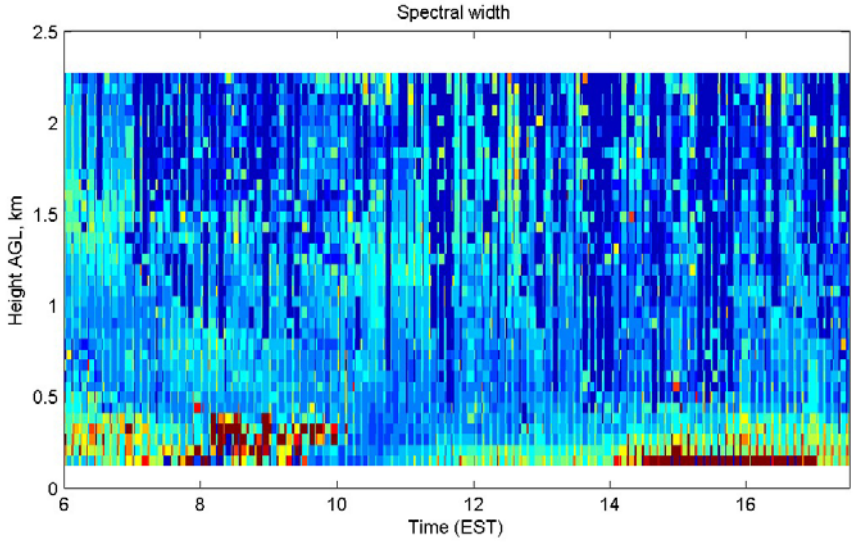




Marine BL

- With advected continental BL in the morning
- (Appledore day 215 2002)





Basic rule

- Profilers can find convective boundary layer when it is defined physically
- Other types of BLs are more challenging
- Sometimes the physical definition of the BL is the issue

How do we find BL height in practice?

- Most reliable method is subjective determination based on reflectivity pattern with all available ancillary measurements
- Some automated algorithms exist in research environments
- Using more information (cloud data, more moments, time & space patterns) yields better results

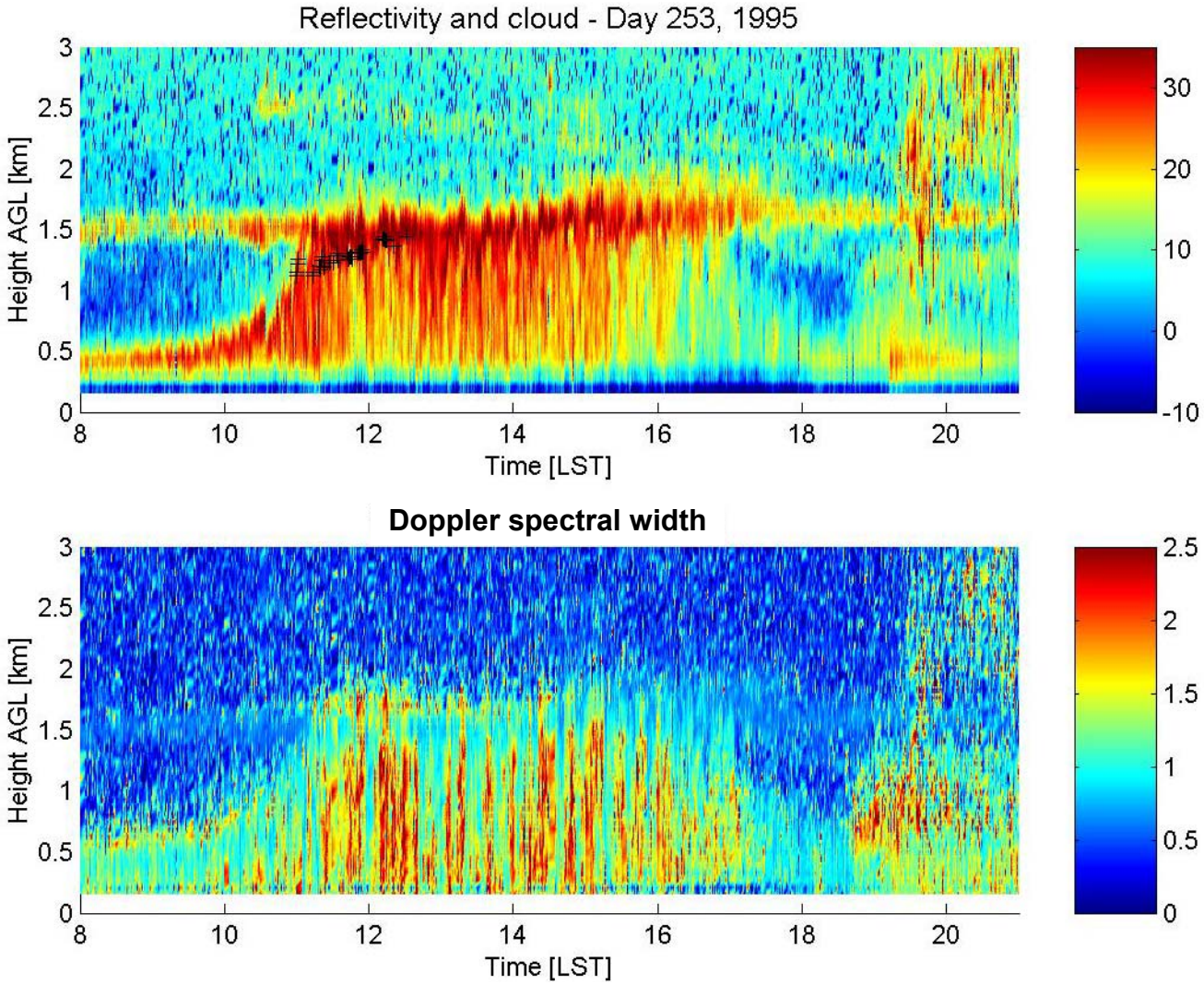
Morning transition

- Transition between nocturnal, stable BL and daytime convective BL
- Profiler reflectivity patterns give a very good indication of timing of morning transition

Afternoon transition

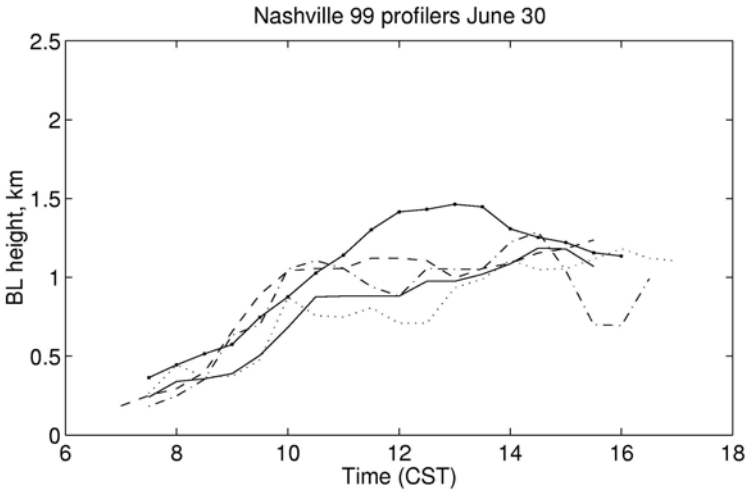
- Transition between fully-developed daytime convective ABL and nocturnal ABL
- Timing and shape of transition are critical to initiation of inertial oscillation / low-level jet, nighttime transport, distribution of pollutants, etc.
- Turbulence gradually decreases in height and intensity
- Reflectivity can be misleading, it tends to show the residual inversion
- Spectral width is most useful to distinguish active turbulent region from developing residual layer

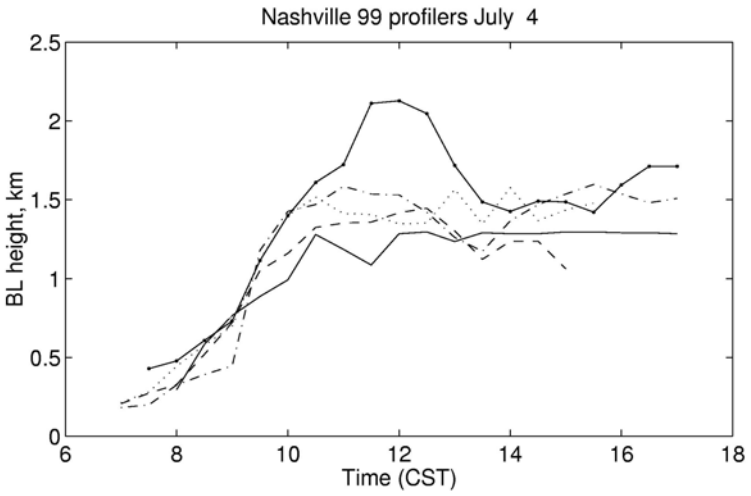
Profiler reflectivity and spectral width patterns for a “typical” day



Spatial variation of BL height

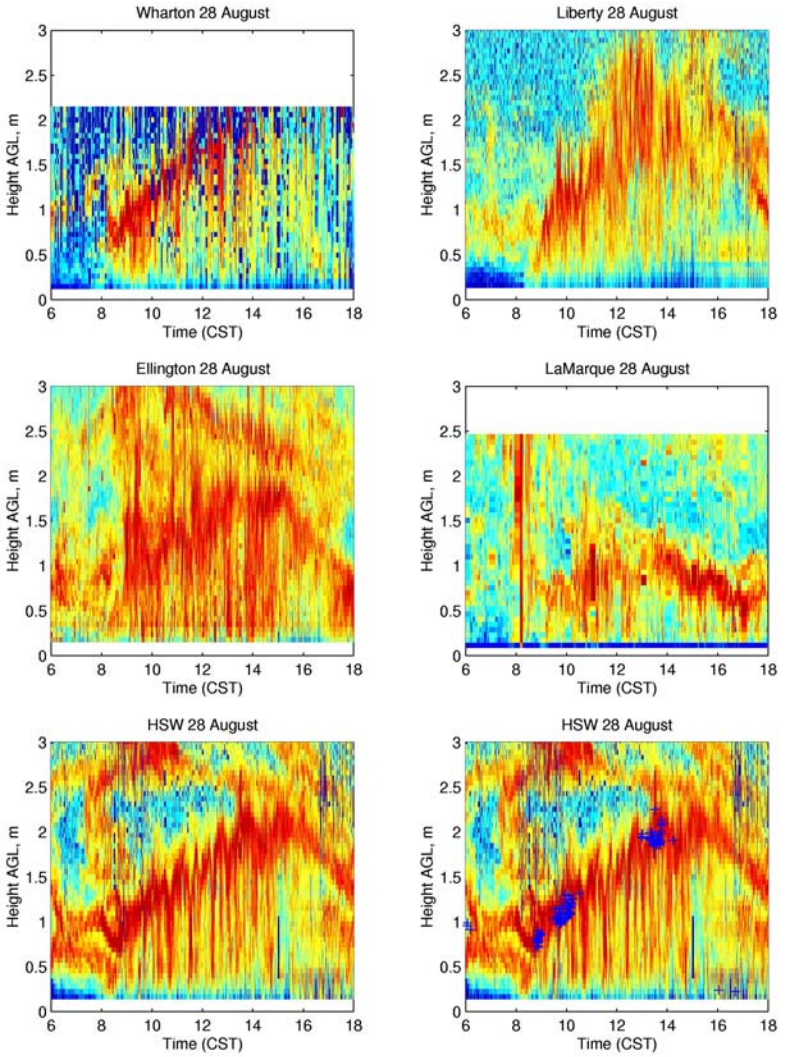
- Urban dome or urban heat island measured by profilers in urban core and in surrounding rural areas
- Implications for pollutant concentration and transport





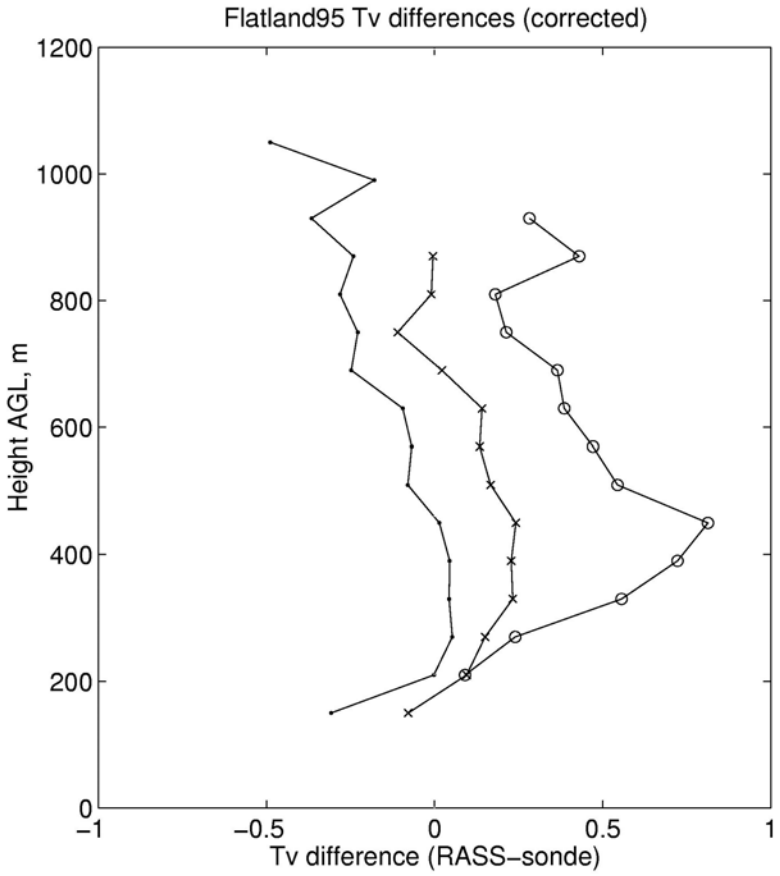
Coastal influence on BL behavior

- Five profilers in Houston area for TEXAQS2000
- LaMarque, near Galveston Bay, shows coastal influence on this day
- We are studying sea breeze influence on pollution episodes
- Also note non-ICRA data at Ellington



RASS

- Many profilers have RASS (Radio Acoustic Sounding System) attached to measure (virtual) temperature
- RASS data can be useful but their limitations must be understood
- Height coverage is limited and varies with wind speed and other conditions
- Height-dependent bias is present due to range error – correction algorithms exist but are non-trivial
- RASS combined with surface data can be useful for finding nocturnal BL heights



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